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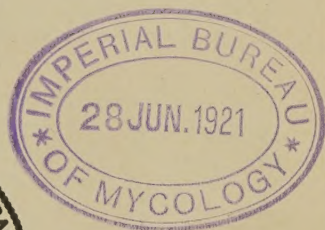
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The Sterilization of Tobacco Seed Beds

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The Sterilization of Tobacco Seed Beds

By G. H. CHAPMAN

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

For some years it has been the custom of many tobacco growers in the Connecticut Valley to sterilize or "steam" their tobacco beds as a means of eradicating diseases and killing weed seed in the seed-beds. Apparently, however, there has been too little uniformity in methods employed or insufficient attention to detail, and as a result, some growers have arrived at the conclusion that sterilization is ineffective as a preventive measure for seed-bed troubles. In all the cases which have come to our attention, where negative results were reported, the trouble has been traced to faulty technique of the grower or the person in charge of the sterilization, or to inadequate apparatus.

The practice of sterilizing the tobacco seed-bed should be much more widespread than at present if growers hope to raise healthy, vigorous plants, particularly as the past three seasons have been peculiarly favorable for the development of certain parasitic diseases, both in the seed-bed and in the field. The root-rot fungus (*Thielavia basicola* Zopf.) in particular is of frequent occurrence in both seed-beds and fields. In the seed-bed it may be very rapidly destructive as the plants grow very close together, with their roots interlacing and usually with very tender tissues. This is an ideal condition for the development of the disease-causing organism. The fungi which cause damping-off may also be present but these can generally be controlled by proper attention to watering and ventilation. They are also controlled by sterilization. Root-rot is perhaps the most important seed-bed disease and in light infections it is one of the hardest for the grower to detect unless a careful examination of the roots is made. Very often it will appear only as a slight browning of the roots, or, as it is often said, the roots appear "burned." In bad infections the plant has very few roots and these are browned or blackened particularly at the broken end, and sometimes the tap root is severely injured. In case of a severe infection the plants usually are very uneven in the bed, both as to size and color, and will often wilt rapidly when the sashes are removed on a bright day.

These diseased plants, if transplanted to the field, infect the field soil, creating new centers from which the disease may become so widely distributed as to make the field unprofitable for the purpose of tobacco growing, owing to the consequent reduction of yield and quality.

It can readily be appreciated that the eradication of the fungus in the seed-bed is a matter of prime importance. Many more seed-beds than had been suspected have been found to be infected with this fungus and last spring (1917) out of more than one hundred beds examined in different localities, eighty per cent, were found to be infected in various degrees with root-rot. In many cases only a slight infection was noted, but there were several beds which had been in use continuously for several years where the infection was very heavy, practically all plants being badly diseased. In no case where the beds had been properly sterilized was the fungus found.

The only effective method for the control of this disease, so far devised, is that of sterilization. No recommendations for absolute control in the field can be made, although it appears that a proper system of rotation or cover crops is often beneficial. However, it is not the purpose of this circular to go into this phase of the matter.

Sterilization will also kill weed seeds and so lessen the expense of weeding. Many weed seeds are killed at a much lower temperature than are fungous spores. Some growers have made a practice of sterilizing to kill weed seeds only, and hence use a lower pressure and temperature than are necessary to kill the fungus. Little can be said regarding the advisability and economy of sterilizing to kill weed seeds only, as so much depends on the character of the soil, the manure used in fertilization and the number of weed seeds present before sterilization. This is a matter for the individual to decide for himself.

METHODS OF STERILIZATION

Many methods of sterilization have been tried in various places but only two have been found to be satisfactory; namely, the steam and "formalin" or formaldehyde treatments. The former is the most generally applied method in this section and is perhaps on the whole better, and somewhat cheaper, than the formalin treatment.

Steam sterilization. The outfit necessary to successfully sterilize by steam consists of a boiler capable of delivering from 80 to 125 lbs. pressure at the boiler, some lengths of good pressure hose, and two or more pans made of heavy galvanized iron or wood of convenient size. One of these pans is inverted over the soil and forced into it for a couple of inches or more. The steam is then turned into it through one or more openings, and allowed to penetrate the soil for at least thirty minutes. In the meantime, a second pan is placed ready for use and at the expiration of the half hour, the steam is shut off from the first and turned into the second pan. The first pan is then allowed to stand for a little time, when it is placed in a new position ready for use again. By the use of two or more pans much time and expense is saved.

A typical outfit is figured below in detail. This, of course, should be adapted to suit local conditions, and the size is a matter of convenience. No estimate of cost is given as this varies widely even in

adjacent localities. It is an easy matter to get an estimate of the cost of the several items from a local plumber or steam fitter. In making the pans, all joints, of course, should be steam tight.

OUTFIT FOR STEAM STERILIZATION

- 1 Boiler capable of delivering 80-125 lbs. pressure (20 H. P.).
- 2 or 3 pans of galvanized iron or wood.
- 50-150 feet (as needed) of 1" pressure hose.

BILL OF MATERIAL FOR ONE PAN—8' x 10'

- 112 sq. ft. galvanized iron No. 20 gauge.
- 36 ft. strap iron 2" x $\frac{3}{16}$ ".
- 2-10 foot pieces angle iron $\frac{3}{16}$ ".
- 1-1" hose connection.
- 1-1" T.
- 2-2' lengths 1" galvanized iron pipe.
- 2-1" elbows.
- 2-4-way T's 1" main and $\frac{1}{2}$ " side openings.
- 8-8" pieces $\frac{1}{2}$ " galvanized pipe (may be omitted).
- Rivets and bolts sufficient.
- 4 handles of iron.

(Or the pans may be constructed of $\frac{7}{8}$ " matched boards lined with tin and properly reinforced with angle iron as above. In case a wooden pan is used the sides should be constructed of 2" x 6" plank.)

It is realized that the cost of a good outfit will be prohibitive to many small growers but if a few would combine to purchase such an outfit, the individual cost would not be great and the benefit to be derived from such co-operation would amply repay the investment.

In many localities there are men with satisfactory outfits who can be hired to sterilize beds either by the day or by some form of contract, and where it is impossible to own an outfit this should be done. There are not enough sterilizers at present to do the work, especially when spring sterilization is practiced, as the beds are sown as early in the season as the condition of the soil will permit, leaving only a short time available for sterilization. The grower should, in any case, see to it that a sufficient pressure (80 to 125 lbs.) is used to sterilize at least four to six inches of the soil and, in some cases, eight inches would be better. *The soil at any depth is sterile if a potato is cooked at that depth in the time allotted.*

Formalin sterilization. This method is sometimes used where it is impracticable to use steam but is not so convenient. It has the further disadvantage of leaving the soil in a heavy, wet condition and if applied in the spring delays planting for at least two weeks.

It is difficult of application on heavy land which contains a large amount of fine silt or clay and comparatively little organic matter.

Commercial "formalin" or formaldehyde is mixed with water in barrels at the rate of 1 part formalin to 50 parts water (1 gallon to 50 gallons of water) and is applied to the beds by means of watering pots at the rate of $\frac{1}{2}$ to $\frac{3}{4}$ gal. to the square foot of surface, depending somewhat on the character of the soil; a light soil will take up the solution more rapidly than a heavy one. Preferably it should be applied slowly enough so that the soil is not soaked sufficiently to be puddled. The beds are then covered with boards or burlap (old fertilizer sacks) for twenty-four hours to prevent too rapid evaporation of the formalin. The soil is then uncovered and the beds may be raked from time to time to hasten the escape of the fumes. *Beds so treated should not be planted* for at least *twelve* days after the application of the formalin; two weeks would be better.

The only outfit needed is some barrels and watering pots. The formalin may be purchased at the drug or agricultural store, or, where large amounts are to be used, direct from the manufacturer.

TIME OF STERILIZATION

Tobacco beds may be sterilized either in the fall or spring by either method. In our opinion, based on actual trial and observations during the past three years, fall sterilization is to be preferred, provided due precautions are taken during the winter to prevent the blowing of weed seeds on to the beds, and to guard against the wash from nearby infected soils. For the most part, growers are not troubled to any considerable extent by weeds in the seed bed, hence the convenience of fall sterilization often more than repays the cost of weeding. Where weeds are abundant it might be well to sterilize in the spring.

The points in favor of fall sterilization may be briefly stated as follows:

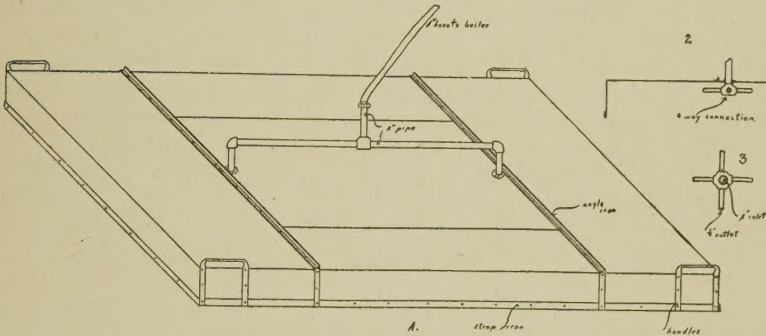
(1) Usually the grower has more time in the late fall to attend to sterilization than during the rush of spring work.

(2) Tobacco beds dry out rapidly after thorough sterilization by steam and need careful and continuous attention to watering if planted immediately. Fall sterilization allows the soil to regain its normal moisture content during the winter and spring.

(3) There is a substance poisonous or toxic to plants produced in sterilized soils which temporarily checks growth. The effects of this substance are not permanent, however, and usually disappear after about two weeks. Fall sterilization prevents injury from the toxin which is washed out or rendered inactive during the winter.

FIG. 1
Pan for Sterilization
 8 x 10 feet

1. General view showing attachment of strap, angle irons, handles and inlet steam pipes. (Not drawn absolutely to scale.)
 2. Cross section showing 4-way steam outlets.
 3. Top view of steam outlets and 4-way connection.
- (Specifications given under bill of material.)



PREPARATION OF BED FOR STERILIZATION

The beds should be ploughed, harrowed, and put into as perfect tilth as possible before sterilization. If manure is applied it should be ploughed under before sterilization. Cottonseed, fish, and mineral fertilizers should be applied *after* sterilization and harrowed in. There is little danger of infection from these substances.

The soil of the bed should not be wet or heavy but as loose as possible. It should not, however, be dried out excessively if the best results are to be obtained. The amount of moisture in the soil is a very important factor especially in finely divided soils, as the rapid penetration of the steam is prevented by the presence of excessive moisture and consequently, if thorough sterilization is to be effected in moist soils, the steam must be applied longer to heat to the desired depth.

It is said that the sterilization of the surface soil to a depth of four inches will control damping-off and root-rot, but in many cases it would be advisable to heat the soil to a depth of six to eight inches. This will give a very thorough sterilization. If the beds are sterilized in the spring, very careful attention must be paid to the watering for some time after sowing as "steamed" beds dry out very rapidly. Unless the soil is watched carefully with regard to this factor, the seed will not germinate well and a loss of the bed sometimes results.

When beds are sterilized in the fall it would be advisable before preparing them in the spring to wash all tools which have previously

been used in the field with a 1-50 solution of formalin to guard against accidental infection taking place from particles of soil, etc., remaining on them.

TEMPERATURE TO WHICH THE SOIL MUST BE HEATED TO EFFECT THOROUGH STERILIZATION

The soil should be heated to a temperature as near 212° Fahrenheit as possible. This, of course, in practice cannot always be obtained. The exact temperature of the soil can be found by using a soil thermometer, but equally good results are obtained if potatoes buried at the desired depth are found to be cooked by the steaming. In using this high-pressure method, care should be exercised to introduce the steam slowly at first, as otherwise there is a tendency of the pans to lift. At the same time, if the full heat of steam is suddenly turned on, there is a very rapid drop of pressure at the boiler, which is undesirable as it takes, in such a case, considerable time to regain pressure.

SUMMARY

The presence of fungi, especially the root-rot fungus, in the soil of seed beds is more widespread than usual at the present time.

Unless these are eradicated, infected plants transfer the fungi to the field where it is practically impossible to control the diseases which they cause.

Steam or "formalin" treatment will effectually control the diseases in the seed bed, in addition to killing weed seeds.

Fall sterilization by either method is to be preferred.

Use a pressure at the boiler of from 80-125 lbs.

Have the beds in as good tilth as possible, neither too wet nor too dry.

Apply manure before sterilization; the other fertilizers should be applied after sterilization.

In the spring be sure that all implements are clean before using on sterilized beds. Wash, if necessary, in formalin 1-50 before using, otherwise infection *may* take place.